Aurora Borealis, Terrestrial Magnetic Disturbances, and Sun-spots.

IN connection with the aurora borealis observed by Major Lockyer on September 28–29 (NATURE, October 6), there was a magnetic disturbance of considerable activity recorded at this observatory. It commenced at 12h., September 28. There were minor movements on the H magnet, D remaining quiet, until a more active phase of the disturbance commenced about 19h., September 28. The major movements on all three magnets, D, H, and V, took place between 1h. 36m. and 4h. 50m., September 29. The extreme ranges on the curves were D 30′, H 82γ, and V 85γ ($\gamma=10^{-5}$ C.G.S. units). The mean daily ranges, for comparison, for the quiet days of September were D 7′, H 36γ, and V 11γ.

The only spot on the sun on September 28–29 was of moderate size, in latitude +8·5 and longitude 56·0, and it was approaching the sun's western limb. But on September 28 the longitude of the central meridian of the sun was 354·1°. This gives the clue to the probable origin of the magnetic disturbance which accompanied the aurora, for the position is very near the longitude of the following spot of the great group of last May, namely, 358·8°, which on its passage across the sun's disc was connected with the series of magnetic disturbances of great violence. These, with a lull on May 18, persisted from May 12 to May 21. This spot-group was on the sun's equator, and also crossed the central meridian on May 14–15 (NATURE, June 2, p. 426).

It appears to be most likely that this region of the sun has remained magnetically active since the series of violent storms of May 12–21. For we get the following sequence of magnetic disturbances, at intervals of 27 or 28 days, corresponding to the period of the sun's synodic rotation:—May 12–21, v.v. great; June 6–10, great; July 7–9, moderate, August 3–5, great; September 2, v. great; and September 28–29, v. great.

The magnets have also been considerably disturbed on the early days of the present month of October, especially on October 5 and October 8. Meanwhile, the sun has been practically spotless. But here, again, with regard at least to the disturbance of October 5, there is a sequence of disturbances corresponding to the synodic rotation period of the sun, which probably has its origin in the later phases of the violent storm of May. The sequence is:—May 21, moderate; June 18, calm; July 15, moderate; August 11, moderate; September 8, great; and October 5, v. great. It will be noticed that in this sequence the magnets were quiet, and activity was in abeyance on June 18.

Since the violent storm of May there have been in all, until October 8, 28 moderate, 2 great, and 4 very great disturbances. All these disturbances, except four marked moderate, fall into four series corresponding to the synodical rotation of the sun, and of these, again, 12 moderate, 2 great, and 3 very great belong to the two series already discussed. It would, therefore, be premature to conclude, from the absence of sun-spots or other surface phenomena of the sun, when a magnetic disturbance occurs, that there is only a casual connection between sun-spots and terrestrial magnetic disturbance. An area on the sun may seemingly remain continuously or recurrently active for several solar rotations, even after the disappearance of the original solar disturbance. Or it may be that clouds of electrons discharged from a very active region on the sun remain undiffused for a considerable period. At the same time it is not evident why the magnetic activity should sometimes actually increase after a lull succeeding the original violent disturbance. Possibly spectro-heliograms in calcium light may help to elucidate the subject.

A. L. CORTIE.

Stonyhurst College Observatory, October 14.

Sex-change in the Native Oyster.

DR. ORTON'S letter on the above subject published in NATURE of July 7, which I have just seen, touches a matter not only of great biological interest, but also of marked importance in the economy of oyster fisheries. I can confirm the presence of spermmorulæ in oysters which are functioning as "white-sick" females, and also the observation that on being placed in sea-water the sperms appear to be fully ripe. There are, however, a large number of oysters, apparently the majority, in any fair sample which may be examined at the breeding season which show no advanced female elements, but are functioning solely as males. These oysters, so far as I have been able to notice, do not show signs of any rapid sex-change.

When one reflects that oysters are naturally found in beds, and that fertilisation requires the free passage of sperms through the water to impregnate functioning females—if we are to discard Lacaze-Dutier's idea of self-fertilisation—it seems inevitable that there is an immensely greater loss amongst the male than amongst the female elements, and the presence of an excess of males seems explained. In the same way the development of active sperms in the gonads of oysters which are already bearing fertilised embryos in their mantle cavities may be a provision to further augment the supply of sperms. The annual breeding period—physical conditions being favourable—is spread over a considerable interval in this country. During the past summer, for instance, free-swimming spat could be found early in June, yet I found oysters with black spat on July 20, and "white-sick" oysters as late as August 26. In that period, it seems probable, from Dr. Orton's observations, that individual oysters may have functioned first as female and then as male shellfish. It would be very interesting to learn, however, if in the Plymouth observations any oysters functioning first as males showed any signs of ripening into females. The annual change of sex which Dr. Orton refers to as possible may be only in those oysters which are first predominantly female in sex. W. L. CALDERWOOD.

Edinburgh, October 14.

A Relation between the Combined Atomic Volumes and their Optical Refractivities.

IT has been shown ("Monograph on Molecular Volumes," Longmans, 1917) that there is a periodic relationship between the atomic volumes of the combined elements. The submultiple 3·6, which is the atomic volume of combined hydrogen, has been found significant.

Table of Atomic Volumes.

	C	Δ	N	Δ	O	Δ	F	Mean
	14·8	(2·8)	12·0	(4·6)	7·4		6·5	3·7
Δ	15·2		15·0		16·1		15·1	
	Si		P		S		Cl	
	30·0		27·0		23·5		21·6	
Δ							7·4	
							Br	
							29·0	
							8·0	
							I	
							37·0	

I, N, and S, mean values.

The atomic volume ratios from solids are F=2S, Cl=6S, Br=8S, and I=12S. The differences now agree with those of the atomic refractions.

(1) There is a decrease in the atomic volume from carbon to fluorine, silicon to chlorine—that is, against increasing atomic weight.

(2) The differences between successive members of the same series are equal to the volume of hydrogen (an approximation).

(3) The difference between the volumes of successive homologues is $n \times 3{\cdot}6$.

n is 4 between series 1 and 2.
n is 2 ,, ,, 2 and 3.
n is 2 ,, ,, 3 and 4.

If the masses be compared, there is a difference of 2 in the first series and $\Delta n = 16$ (4×4), 44, and 47 respectively between groups 2 to 1, 3 to 2, and 4 to 3. It follows that there is a concentration of matter from within to without, or that members of the first and second series are less condensed than those of succeeding series.

There is also a difference of 3·7 between alternative values of a single element:—O 11 and 7·4, Δ 3·6, S 25·0 and 21·6, 3·4, and so on.

The volumes thus indicate that the elements are built up from discrete parts which are similar for all the elements. The indication is, of course, not exceptionally clear, but it is very pronounced. This is not surprising, seeing that liquids are subject to so many different influences.

If A.V.'s be plotted against A.M.'s, paraboloid curves are formed (*a*) at 6·1, in solid state, (*b*) at absolute zero $b \times 10^5$. Note especially the rare gases Ne 76, Ar 144, Kr 177, Xe 228–251, Nit 287 (*cf.* R. N. Pease, Journ. Amer. Chem. Soc., May, 1921).

A periodic relationship also exists between the atomic refractions. Traube was the first to indicate a valency relationship, but in a very imperfect manner.

Table of Atomic Refractivities.

C	Δ	N	Δ	O	Δ	F
3·36	(0·98)	2·38	(0·90)	1·48	(0·81)	0·67
		5·38		5·31		5·29
Si		P		S		Cl
8·80	(1·04)	7·76	(0·97)	6·79	(0·83)	5·96
				(7·76)		
		2·74				2·73
		As		Se		Br
		10·50		(10·86)	1·10	8·79
				9·89		
						5·08
						I
						13·87

Similar serial and group relationships are noticed in the atomic refractions as in the atomic volumes. First, successive differences of from 0·81 to 1·04 are noticed from element to element in the different series, and this corresponds to the atomic refractivity of hydrogen, or, showing a rough proportionality to their respective valencies, C 3·36 (4×0·84), N 2·36 (3×0·79), O 1·48 (2×0·74), F 1×0·67, Ne 0. The atomic refractivities, however, differ considerably in different circumstances.

The differences between the values for homo'ogues are again a considerable multiple of the unit—$n=4$ (4×1·33) between the first and second groups, 2 (2×1·34) between the second and third groups, and again 4 (4×1·27) between the third and fourth groups. The unit is, however, larger in the group differences than in the serial (0·81 to 1·06). We know that there is justification for these multiples from observations on atomic degradation phenomena. Dividing by 8 the ratio is equal to 0·67, which is similar to the valency value.

A relation can be found between the atomic refractions for members of the two short series if the number of helium (2) *plus* latent valency electrons be added to the number of *acting* valencies.

$r_a(E_1) = (\mathrm{He}+\mathrm{L.V.}) \times 0 + n(\mathrm{F.V.}) \times 0{\cdot}74$
$r_a(\mathrm{C}) = 3$ approx. $\quad N_{\mathrm{C}} = 2+0+4=6$ A.N. $=6$
$r_a(\mathrm{F}) = 0{\cdot}74 \quad N_{\mathrm{F}} = 2+6+1=9$ A.N. $=9$
$r_a(E_1) = (\mathrm{He}+\mathrm{L.V.}) \times 0 + 8 \times 0{\cdot}67 + n(\mathrm{F.V.}) \times 0{\cdot}74$
$r_a(\mathrm{Cl}) = 6 \quad N_{\mathrm{Cl}} = 2+6+8+1=17$ A.N. $=17$
$r_a(\mathrm{P}) = 7{\cdot}58 \quad N_{\mathrm{P}} = 2+2+8+3=15$ A.N. $=15$
$r_a(\mathrm{Br}) = 8{\cdot}78 \quad N_{\mathrm{Br}} = 2+6+12+1=21$
$r_a(\mathrm{As}) = 7{\cdot}58 \quad N_{\mathrm{As}} = 2+2+12+3=19$

It is evident that the numbers for members of the third series fall short of the atomic numbers.

Mn. A.N. 25 $N_{\mathrm{Br}}21$ Δ4
V A.N. 23 $N_{\mathrm{As}}19$ Δ4
Br. A.N. 35 $N_{\mathrm{Br}}21$ Δ14, or 12, if members of the eighth group number only one (isotopes).
As. A.N. 33 $N_{\mathrm{As}}19$ Δ14.

From this it follows that a larger nucleus of the members of the longer series becomes impermeable to light, the number being much greater for even series of period 3. These considerations point to the fact that some central condition produces a repelling power on light-waves of moderate length and speed, whilst, on the other hand, the electrical rather than the material elements tend to retard the light.

It is thus seen that there is a clear and distinct connection between the atomic volumes, the atomic refractions, the make-up of the elements, and also their evolution from sub-atomic discrete electrified particles.

The accompanying curve (Fig. 1) shows the nature of the relationship in a general way, and this is approximately rectilinear.

Expressed numerically, this becomes

$$\frac{V^{1}-V_{F}}{R^{1}_{a}-R}=2{\cdot}58$$

also

$$\frac{15{\cdot}0}{5{\cdot}3}=2{\cdot}8$$

The differences $\frac{\Delta V}{\Delta r_a}$ between series are 2·8, 2·7, and 1·2 respectively, the latter being small because $n=1$ for one property and 2 for the other.

The relation $\frac{\Delta V}{\Delta r_a}$ is equal to 4 between successive groups.

The light-waves from the evidence of optical refractivities appear to pass chiefly through the gaps between the atoms A | B | C | D, as through a grating encountering the valency electrons which tend to retard them. Only single rings of electrons in the first series are affected by the light-waves, the nuclei not being affected. This is shown by the diminishing refractivities with the increase of atomic masses in the regions of the periodic system under examination. In the second and subsequent series a shell of electrons (several rings) is influenced,—a similar kernel not being affected. Any influence which causes the electrons to be drawn more into paths of light (unsaturation) results in an increase of the refractivity.

If the electrons be supposed to be distributed in space, according to principles of equal distribution in the same atom,[1] with, perhaps, constraining disturbances in position in some combinations, it is probable that a definite and approximately equal share of space must be accorded to each electron. The approximately rectilinear curve points to this fact. Both properties, however, differ somewhat in different combinations, so that some slight modification is to be understood. It is, however, sufficiently interesting to be able to trace such a relation when it is considered that neither the atomic volumes nor refractions can be directly measured, but are derived constants.

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[1] Octahedral models for rare gases (spheres).

Some of the variations seem to point to variable relations with the ethereal medium. Negative anomalies, for example, are at present incomprehensible, the whole of the atomic refractions of, say, oxygen in $P(OEt)_3$, for example, disappearing entirely. Some of the *per saltum* changes are equally difficult to explain. The periodic relationship between the elements points rather to a spiral arrangement (understood in a solid sense)[2] of the electrons than to a series of rings. This arrangement is due to the fact that the spiral is one of the natural modes of motion of the æther and discrete particles immersed in it. This is shown in the case of spiral nebulæ. The vortex is another condition. Gradual disintegration of the atoms is thus more easily understood, and devolution is reversed evolution.

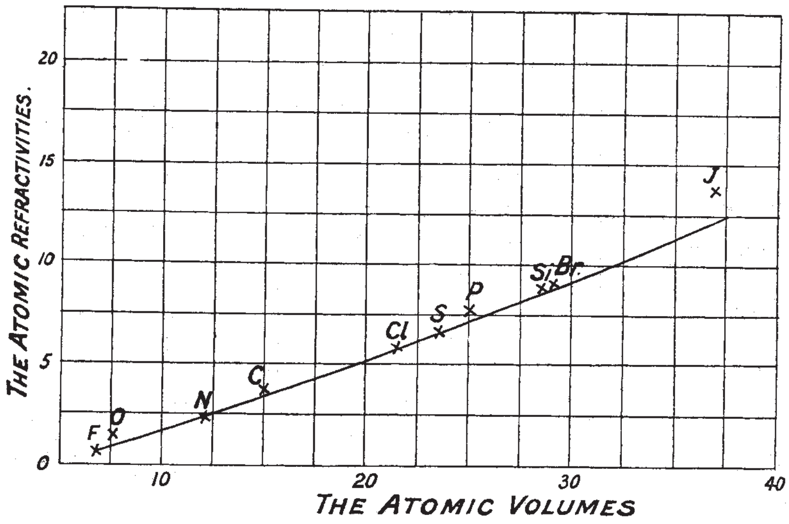

FIG. 1.—A relation between the atomic volumes and the atomic refractivities.

Up to the present the charge on the electron is regarded as static, but the existence of magnetic properties suggests rotations of electricity on the material particles. This would result in a magnetic flux. It, however, seems to be impossible to distinguish the charges within the atom.

Note.—A numerical relation with the atomic masses suggests itself. $m = 3r_a \times F$, F being a factor probably representing concentration of matter (atomic density).

$m = b_0 \times F$ b_0 for A.Z.

$\frac{m}{b_0} = F(2, 2, 3, 3)$ not for first series except for C.

Cl	$6 \times 3 \times 2 =$	36
Mn	$8{\cdot}8 \times 3 \times 2 =$	52·8 (55)
Br	$8{\cdot}8 \times 3 \times 3 =$	79·2 (79·6)
I	$13{\cdot}9 \times 3 \times 3 =$	125·1 (126).

F diminishes from group 7 to 4 and increases differently in the groups. This relation is, however, based on products, whilst the additive cumulative factor is evident; still, the relation is interesting. The next homologue after Cl is Br (red liquid). There is, however, a large gap between the two. Instead of an easily condensible yellow-red vapour at 55, by some twist we get a metal. There is a similar disparity between Br and I. GERVAISE LE BAS.

6 Springfield Crescent, St. Heliers, Jersey.

Hybridity and the Evolution of Species.

As the author of the "Theory of Evolution by Means of Hybridisation," I am naturally much interested in the recent papers by Dr. Harrison and Miss Blackburn, which proved beyond any reasonable doubt that most British rose-species are of hybrid origin, though this was not suspected. The authors based their conclusion that hybridity is one of the prime factors in the evolution of species, if not the only one, on their cytological results, which agree with those of Tackholm on a much larger number of rose-species from all parts of the world. The reviewer of their papers in NATURE of September 15, p. 99, does full justice to the importance of these results, and directs attention to Jeffrey's work tending to show that the presence of "bad pollen" is proof of a hybrid origin—a view much strengthened by Brainerd and Petersen's study of the New England *Rubi* (Vermont Agric. Expt. Sta. Bull. No. 217), in the course of which they find much hybridisation and no forms with entirely good pollen.

To this view the reviewer takes exception. That "bad pollen" is unsafe as a criterion of hybridity is shown, he says, however, by other results. As such he considers the fact that isolated species, such as the Californian *Trillium giganteum,* the nearest relative of which is in the Eastern States, possess a certain amount of bad pollen. I am sorry to say that I fail to see the bearing of a now isolated habitat on the problem in question. I suppose that the reviewer will agree with me that the origin of *Oenothera biennis,* which for several centuries has been a feature of the flora of the dunes in many European countries originated elsewhere than in Europe; so why should *Trillium giganteum,* and *Dirca occidentalis* and *Scoliopus Bigelovii,* the other two species with bad pollen which he quotes as proof of his contention, have originated at the spots they now occupy? And if they originated somewhere else, the argument against their possible origin by crossing does not hold good.

Velp, Holland, October 4. J. P. LOTSY.

IT is perhaps only natural that Dr. Lotsy should take a special view of any facts that bear on his theory of evolution by hybridisation, but in the above letter he is clearly begging the question. In the article on British roses and hybridity to which he refers it was pointed out that the original authors did not consider *all* British roses to be hybrids, but looked upon the diploid forms and the Pimpinellifoliæ as pure species. In such cases as Trillium, Dirca, and Scoliopus, it is not sufficient for him to suggest that they must be hybrids merely because they have bad pollen. The fact, previously cited, that

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[2] A spherical *tourbouillon* with a vortical centre and a peripheral rotation (model slip-knot).